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RESULTS OF WORK ON BLISTER BEETLES IN KANSAS.

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CONTENTS.

INTRODUCTION.

In the drier portions of western Kansas and adjoining States the insect fauna is particularly rich in blister beetles. Besides those of common occurrence elsewhere there are several species that are characteristic of the region. The native grasshoppers develop regularly in considerable numbers, thus insuring sustenance for some, at least, of the blister-beetle larvæ. The beetles feed on native legumes and other plants that root deeply and make some growth even when cultivated crops and shallow-rooted weeds die of drought.

The abundance of blister beetles in this region was noted by early entomologists, mostly systematists, who chanced through the western and southwestern United States; but it remained for Dr. C. V. Riley, while entomologist of Missouri, to work out the first life histories of American species, and later as a member of the U. S. Entomological Commission to extend his researches in this line. Riley studied only species of general occurrence and only two of them to completion, yet he announced as his opinion that the life histories of other species would be found strictly parallel to these.

With the subsidence of outbreaks of the Rocky Mountain grasshopper (*Melanoplus spretus* Uhler), the Commission directed its attention to the more pressing problems of thickly settled portions of the country. The writer knows of no further study of the economic relations or biology of American species of this group.

The data on blister beetles that form the basis of this bulletin were collected, except as otherwise specified, since 1913. From March, 1913, to May, 1915, inclusive, the work was conducted at Garden City, Kans. From June, 1915, to June, 1917, inclusive, it was continued at Wichita, Kans. As the beetles do not occur there in sufficient numbers to supply the necessary material, work on control measures was dropped, and only such life-history work was conducted as was possible with material collected on infrequent trips at irregular intervals to western Kansas.

ECONOMIC IMPORTANCE.

There has been a tendency among entomologists to class the western species of blister beetles as beneficial. This arises from the fact that their larvæ feed on the eggs of grasshoppers, from the ravages of which the early agriculture of the plains region suffered immensely. However, the species of grasshopper responsible for a large share of the injury, and the one that stands to-day an insect bogy to those of limited entomological knowledge, has disappeared from the scenes of its former activity so completely that specimens of it are curiosities to the new generation of entomologists.

Only since the agricultural possibilities of the semiarid regions have been developed along diverse lines has it been possible to form a true estimate of the economic status of blister beetles. The presence of extensive acreages of sugar beet, alfalfa, beans, and peanuts has allowed them to exhibit to the full their propensity as crop destroyers. The cultivation of large areas and the close pasturage of a great deal more have also altered the flora and environment to such an extent that the former equilibrium of the insect fauna has been disturbed. Cultivation has insured a much more extensive food supply for grasshoppers, and they have become distributed accordingly; but much of this increase in the food of grasshoppers has not been accompanied by a corresponding increase in food suitable for the adult blister beetles. The latter have, therefore, been unable to spread so widely. Pasturage or other disturbance incident to the agricultural use of the land has proved a greater detriment to the blister beetles than to the grasshoppers. Even in localities where blister beetles are most abundant repressive measures for grasshoppers have been found necessary. Also, where blister-beetle larvæ infest a large percentage of the grasshopper egg capsules, they must destroy many larvæ of the beefly *Anastoechus nitidulis* Fab., and of the hymenopterous egg parasite *Scelio monticola* Brues, neither of which is known to be injurious in any stage. The larvæ of the beefly destroy a great many more grasshopper eggs than the larvæ of the blister beetles, but are helpless against the latter when they enter the same egg capsules.

It is questionable whether blister-beetle larvæ have ever been sufficiently beneficial to offset the damage done by the adults. Certainly they are now relatively of much less value than formerly. The group, therefore, must be considered injurious and will become more so with continued agricultural development of the semiarid sections.

INJURY TO CROPS.

Blister beetles may devour only the petals and pollen of the flowers. They usually do this on beans, peanuts, and locust trees, and largely on alfalfa. On Irish potatoes, sugar beets, and to a lesser extent on the Russian olive, however, they commonly defoliate the plant. In either case the actual injury to the crop depends on the stage of growth which the plants have reached. When they are near maturity the yield is lessened, but the crop is not a total loss. Unless drought prevails at the time of defoliation, sugar beets usually put forth new leaves and continue their growth, but the effect of defoliation is recorded in decreased tonnage or sugar content, or both. A defoliation of Irish potato is usually disastrous, as is also the destruction of the blossoms of beans and of peanuts.

FOOD PLANTS.

Leaf-feeding insects, like the blister beetles, could not become as numerous in the semiarid regions as they do without the presence of some hardy native plant upon which they can feed during drought. At Garden City, Kans., the beetles feed upon the blossoms of the sunflower (*Helianthus* spp.), the goldenrod (*Solidago* spp.), the leaves and flowers of the few-flowered psoralea or scurvy pea (*Psoralea tenuiflora*), and on other prairie legumes. They also feed extensively on an introduced weed, the ground burnut (*Tribulus terrestris*).

The cultivated plants which they attack most extensively are the Irish potato (*Solanum tuberosum*), the sugar and garden beets (*Beta *vulgaris*), alfalfa (*Medicago sativa*), the garden bean (*Phaseolus* spp.), the peanut (*Arachis hypogaea*), and sweet clover (*Melilotus alba*). The writer has not noticed them feeding much on other plants, but references to literature show that they attack a great variety of vegetation.

As the beetles emerge they begin feeding on such plants as they find near by. Later they are driven to cultivated plants, because drought has killed the weeds or because they need a more abundant and continuous food supply to support them in their gregarious habits.

CLASSIFICATION OF SPECIES STUDIED.

The blister beetles belong to the coleopterous family Meloidae, the members of which contain in their bodies a substance that blisters when extracted and applied to the skin. Both subfamilies, Meloinae and Cantharinae, are represented in these studies, though only one genus of Meloinae was identified. This was Meloe, about 30 specimens of an undetermined species of which were collected (Chttn. No. 2507). All of these were found along a short piece of roadway which was flanked on one side by a field of wheat and on the other by a weedy prairie pasture. The species may have been only recently introduced in this locality, as it was but a few rods from the bank of a main irrigation ditch which comes directly from the Arkansas River. It was not to be found elsewhere at Garden City. Specimens were secured April 24, May 7, and May 19, 1914. On May 7 one pair was taken in copula, but no eggs were secured. The immature stages were not observed, nor were the beetles seen feeding except on the young Russian thistle.

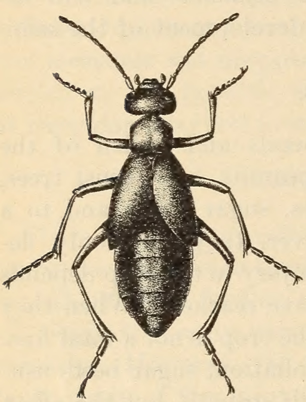

FIG. 1.—*Meloe afer:* Adult. Enlarged.

DESCRIPTION OF MELOE SP.

ADULT.

Near *afer* Bland. or *barbarus* Lec. (Chttn. No. 2507) : Length, 8 to 12.5 mm.; width, 3 to 4 mm.; elytra diverging, truncated, the body being widest across the abdomen near their tips; color black; rough and feebly shining. (Fig. 1.)

Of the subfamily Cantharinae, two tribes, Nemognathini and Cantharini, were represented.

The specimens of Nemognathini were identified as belonging to one genus and three species, *Nemognatha lurida* Lec., *N. bicolor* Lec., and *N. piezata* Fab. They were intermingling freely on blossoms of the bull-thistle (*Cirsium lanceolatum*) and on account of their intergrading color patterns could easily have been referred to a single species. They were not observed in any injurious connection, and their immature stages were not found.

The tribe Cantharini was represented by three genera—Macrobasis, Epicauta, and Cantharis. To Macrobasis and Epicauta belong the injurious species occurring at Garden City, Kans., and they are treated at length in this paper. Of the genus Cantharis only one species was identified, *Cantharis reticulata* Say, of which a very few specimens were collected. They are sufficient for only a brief description.

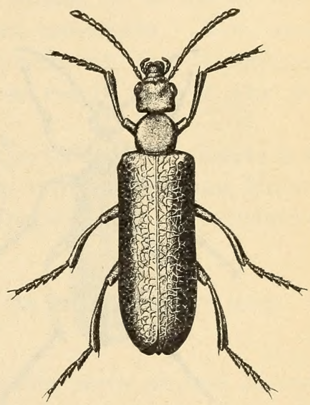

Fig. 2.—*Cantharis reticulata*: Adult. Enlarged.

Description of Cantharis reticulata Say.

Adult.

Length, about 15 to 25 mm.; width, about 4.5 to 7 mm.; color black, except antennæ and legs, which are dark brown. Elytra irregularly ridged, hence the name; head, thorax, and abdomen pitted and sparsely haired; legs thickly haired. (Fig. 2.)

The adults were taken on the bush morning-glory (*Ipomoea leptophylla*), excepting one which was found on alfalfa.

Besides *Cantharis reticulata*, the tribe Cantharini is represented at Garden City by at least 15 species, of which four belong to the genus Macrobasis and 11 to Epicauta. For the purposes of this paper the generic and specific distinctions are sufficiently set forth by the key, which has been adapted from Horn with the assistance of H. S. Barber, of the United States National Museum.

KEY TO SPECIES OF EPICAUTA AND MACROBASIS COLLECTED AT GARDEN CITY, KANS.

A. Second joint of antennæ at least half as long as third__________Macrobasis.
- a. Black with posterior margins of abdominal segments gray. *M. segmentata* Say.
- aa. Gray, yellowish, or brownish, unicolorous or with markings.
  - b. Prothorax usually with two longitudinal black stripes; elytra usually concolorous, sometimes with submarginal black stripes; basal joints of antennæ brown (fig. 3)__________*M. albida* Say.
  - bb. Unicolorous.
    - c. First joint of antennæ as long as or longer than the second and third together. In the male it reaches to the occiput, and the second is at least twice as long and twice as thick as the third__________*M. unicolor* Kirby.
    - cc. First joint of antennæ similar in sexes, second joint shorter than third______________*M. immaculata* Say.

AA. Second joint of antennæ less than half as long as third ---------- Epicauta.
a. Antennal joints elongate, loosely united.
b. Unicolorous.
c. Gray or yellowish ---------- *E. cinerea* Forst.
cc. Black.
d. Large, 25 to 30 mm. long ---------- *E. corvina* Lec.
dd. Less than 20 mm. long.
e. Spurs of hind tibia stout, cylindrical; length 12 to 20 mm. (fig. 4) -- *E. funebris* Horn.
ee. Spurs of hind tibia slender, acute at tip and unlike, the outer spur being broader; length 8.5 to 14 mm -- *E. pennsylvanica* DeG.

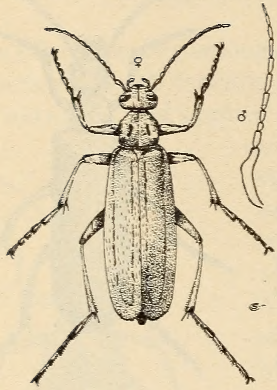

FIG. 3.—The two-spotted blister beetle (*Macrobasis albida*): Adult, striped variation. Enlarged.

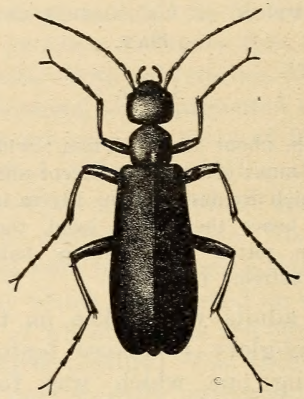

FIG. 4.—*Epicauta funebris*: Adult. Enlarged.

bb. Variegated.
c. Gray or yellowish with black markings.
d. With three longitudinal black stripes on each elytron ---------- *E. lemniscata* Fab.
dd. Spotted with black.
e. Spots minute, scattering ---- *E. maculata* Say.
ee. Spots larger, crowded, sometimes coalescent. *E. pardalis* Lec.
cc. Black, elytra and prothorax margined with gray, and median line of prothorax gray ---------- *E. marginata* Fab.
aa. Antennal joints short, closely united.
b. Pronotum with pair of bare, smooth, black areas; color reddish or grayish brown ---------- *E. callosa* Lec.
bb. Pronotum unmarked.
c. Surface of pronotum moderately shining under vestiture ---------- *E. ferruginea* Say.
cc. Surface of pronotum opaque ---------- *E. sericans* Lec.

The only distinction between Macrobasis and Epicauta is in the relative length of the second segment of the antennæ (figs. 5, 6). In

Macrobasis it is at least half as long as the third and usually more. In Epicauta it is less than half as long as the third.

The four species of Macrobasis are easily distinguished, and no well-marked varieties in a species were observed. But there is great variation in the shade of color, especially in *M. immaculata*, and in the extent of the black submarginal stripes on the elytra in *M. albida*. These stripes next the outer and the inner margin of each elytron, if present, may extend so far as to unite at the distal end, forming a U that opens anteriorly. The black stripes on the prothorax may sometimes be lacking, but so rarely that it was not noted in the key.

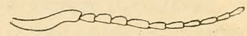

FIG. 5.—The spotless blister beetle (*Macrobasis immaculata*): Antenna of male. Much enlarged.

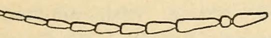

FIG. 6.—*Epicauta corvina*: Antenna. Much enlarged.

As might be expected, since Epicauta is so much more richly represented than Macrobasis, it has greater variation within its species; also the separation of the species is much more difficult.

CHARACTER OF ADDITIONAL DATA ON MACROBASIS AND EPICAUTA.

In the rearing work eggs of several species were secured in confinement and hatched, giving authentic eggs and triungulins. No larvæ have been carried through the growing stages. Attempts to do so were thwarted by the high percentage of parasitism which existed among grasshopper egg-capsules that were collected for the purpose, and the writer was unable to secure eggs of grasshoppers by confining them. Coarctate larvæ were collected and kept under observation during the succeeding transformations. These yielded authentic material for the identification and description of the later stages.

In presenting the data relating to each genus the species on which they are most nearly complete will be considered first.

RESULTS OF WORK ON MACROBASIS.

DESCRIPTIVE.

MACROBASIS IMMACULATA SAY.

ADULT.

Macrobasis immaculata is among the largest blister beetles found in Kansas. A number taken at Garden City averaged 17.5 mm. long by 4.5 mm. wide. Blatchley gives the limits of its variation in length as 13 to 23 mm. Color gray to light reddish brown. According to Blatchley, the sexes are distinguished by the third antennal joint in the male being longer than the second, but in the female of only equal length or shorter.

EGG.

Length, 1.5 mm.; width, 0.5 mm.; shape almost cylindrical, but tapering slightly toward the posterior end; color translucent yellowish white.

LARVA.

Triungulin (fig. 7).—Length, 2.7 mm.; width, 0.5 mm. through the head; shape elongate triangular, tapering gradually to the posterior end, which is bluntly rounded; color yellow or light brown, with lighter bands on the parts of segments that fold against one another when the body contracts in length; legs 3-jointed, strong; claws three in number (hence the name triungulin), slender, the two outer ones spinelike; eyes apparently only pigmented spots behind the antennæ on the anterior part of and near the outer margins of the head; mandibles flat, sickle-shaped, strong, with notched inner margins; antennæ apparently 3-jointed, the third joint divided with the dorsal portion the larger and bearing several spinose hairs; spiracles 9 in number and located above the lateral margins; armature of abdomen consisting of spinose hairs, about 10 in a transverse row near the posterior margin of each segment, and about 6 in a row nearer the anterior margin, those in each row so placed as to be in rows with corresponding hairs on the other abdominal segments; anal segment with two diverging hairs one-fourth to one-third length of body, projecting posteriorly from above its tip; hairs also regularly placed on thorax, head, and upper and outer surfaces of mandibles; legs with stiff hairs projecting perpendicularly on the femur but appressed on the tibia.

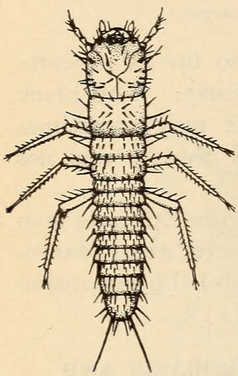

FIG. 7.—*Macrobasis immaculata:* Triungulin.

Carabidoid and scarabaeidoid larvæ.—Descriptions of these stages could not be secured from authentic specimens, as they were not reared. Collected larvæ that were thought to be in these stages were similar to those figured by Riley[1] for *Epicauta vittata.*

Coarctate larva (fig. 8).—Length, 11.5 to 13.5 mm.; width, 4.5 to 6.5 mm.; shape elongate hemispherical, resembling the half of a peanut kernel if the ends of the latter were bent toward its flat side and its edges thickened; color reddish brown; entirely inactive, the skin rigid; location of appendages shown by tubercular projections; limits of head shown by a constriction near the anterior end; segmentation of body plainly shown dorsally but less distinct ventrally; spiracles in shallow depressed line above the thickened edges.

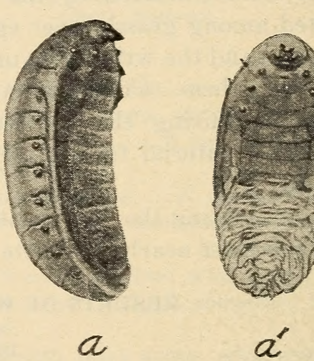

FIG. 8.—*Macrobasis immaculata,* coarctate larva: *a,* Lateral view; *a',* ventral view. Enlarged.

Third larva.—Measurements difficult to make, though greater than for the coarctate larva; color white; shape robust, fleshy, and much wrinkled, larva

[1] RILEY, C. V., PACKARD, A. S., and THOMAS, CYRUS. FIRST ANNUAL REPORT, U. S. Ent. Comm., Dept. Interior, U. S. Geol. Survey, 1877, pl. IV, figs. 4–7. 1878.

assuming a horseshoe shape when at rest; head horny, yellowish, with front almost vertical; mandibles brown, curved; antennæ situated above the outer edges of the bases of the mandibles, apparently three-jointed, with two fleshy projections on the distal end of the third segment; first and second antennal segments with basal rings of brown and third segment brown for almost its entire length; eyes minute black spots above the bases of the antennæ; sutures extending diagonally backward from the bases of the antennæ, meeting at the median line above the middle of the front; labrum separated from the front by a brown suture; legs fleshy, jointed, the distal ends thickly studded with stiff brown spines; spiracles on second body segment and on fourth to eleventh, inclusive.

Pupa.

Length, about 17 mm.; width, about 7 mm. (measured from tip to tip transversely extended femora); color yellowish white with translucent appendages; head appressed on prothorax until front is almost parallel with body; femur and tibia of each leg folded together and extending forward, upward, and outward; tarsi extending posteriorly on the venter; antennæ extending posteriorly dorsal to the anterior and middle legs; posterior margins of prothorax and abdominal segments bearing stiff, curved spines.

Macrobasis unicolor Kirby.

Adult.

Specimens of *Macrobasis unicolor* collected at Garden City, Kans., averaged about 13.6 mm. long and 3.4 mm. wide. Blatchley gives the limits of their variation in length as 8 to 15 mm. It is the slenderest of our species (fig. 9) and the sides are almost parallel; color ashy gray, sometimes with a yellowish cast, but more uniform than in any other species collected at Garden City, except the black ones.

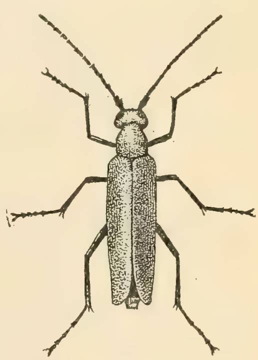

Fig. 9.—The ash-gray blister beetle (*Macrobasis unicolor*): Female beetle. Enlarged. (Chittenden.)

Egg.

The eggs were not secured nor were the growing stages of the larvæ identified.

Coarctate Larva.

Five specimens vary in length from 10 to 12 mm., and in width from 4.5 to 5.5 mm. They are rather slender and of a yellowish brown color. In other ways they agree with the coarctate larvæ of *Macrobasis immaculata*.

Third Larva.

Smaller and more slender than the corresponding stage in *M. immaculata*, but otherwise similar thereto.

Pupa.

The only specimen measured was 10 mm. long by 3 mm. wide. Though smaller and more slender it was otherwise similar to the pupa of *M. immaculata*.

LIFE HISTORY AND HABITS.

MACROBASIS IMMACULATA SAY.

OVIPOSITION.

The female of *Macrobasis immaculata* deposits her eggs in small cavities (fig. 10) prepared in the soil wherever she may be feeding. In confinement no special preparation or arrangement could be observed. While on the staff of the Kansas Experiment Station the writer once observed oviposition in the field. The ovipositing female first came under observation about 3.30 p. m. She was busily engaged in excavating and continued thus as long as watched. The place was marked, and the writer returned at 6 o'clock to find her still at work. The next forenoon the spot where the beetle had worked had been smoothed over, nothing remaining to indicate the location of the eggs except the identifying marks. Careful excavation revealed the outlines of a bell-shaped cavity in which the dirt had been replaced and loosely packed. In the center of the floor was a smaller cavity that contained a mass of several hundred eggs. The eggs were about 1½ inches below the surface, and without definite arrangement or protective covering.

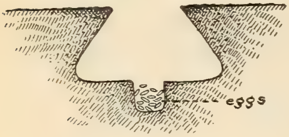

FIG. 10.—Cavity prepared for eggs by female of *Macrobasis immaculata*.

The earliest date at which eggs were secured in confinement was July 22 and the latest September 9.

INCUBATION.

As incubation proceeds the young larva soon becomes visible through the transparent shell. The body is translucent, distinctly segmented, and the head is closely appressed on the venter. The mouth parts extend backward below. The eyes are black, the tips of appendages brown, and the spiracles are ringed with brown. The hairs are closely pressed to the body, the two long ones on the anal segment being bent around so as to extend forward at the sides.

Eggs deposited July 22 hatched August 3, and some deposited July 24 hatched on August 5 and 6. The incubation period is thus from 12 to 14 days in length, but this becomes increased during cooler weather.

HABITS AND GROWTH OF LARVA.

The newly hatched larva soon becomes active. Where the beetles are numerous during the summer the little triungulins soon abound. and close observation will discover them hurrying about over the ground. They go into every crevice and under every clod and piece of vegetable matter. Their mode of locating and entering grasshopper egg capsules has never been observed by the writer; but a few weeks later the large, plump, white scarabaeidoid larvæ and the reddish-brown coarctate larvæ have been found in capsules of grasshopper eggs. Probably a large percentage of the triungulins fail to find grasshopper eggs and perish from starvation. The fact that not more than one larva is ever found in a capsule indicates a further mortality through struggles between rival claimants for egg masses, since where the triungulins are so numerous it seems certain that more than one would enter each capsule of eggs.

All evidence that has been secured as to the rate of growth and the character of the accompanying transformations indicates that they are similar to and probably parallel with those decribed by Riley,[2] in the case of *Epicauta vittata.*

On becoming full grown the larvæ burrow away from the egg-capsules they have emptied, usually going much deeper, then turning toward the surface. There each larva forms an elliptical chamber at a slight angle with the perpendicular, stiffens out with the head uppermost, and sheds the old larval skin, which remains around the posterior portion of the abdomen. This leaves the elongate hemispherical coarctate larva standing almost vertically on end in the old exuvium and supported near the anterior end by the dorsal portion resting against the wall of the cell. The depth at which coarctate larvæ are found varies, being from 3 to 6 inches below the surface.

The coarctate larvæ have been found from late in summer until late the next spring. No scarabaeidoid larvæ large enough to belong to this species have been found during the winter or spring. This indicates that the species hibernates only in the coarctate larval stage.

After the spring's warmth penetrates to the coarctate larva the rigid skin splits along the anterior portion of the dorsal line. The third larva wriggles out and burrows toward the surface. The writer's earliest record of this transformation is dated May 28, but another record gives pupation on May 27, so it is safe to say that the third larvæ begin to appear in Kansas about May 20.

PUPATION.

After a few days' activity the third larva has approached to within 1 or 2 inches of the surface. Here it constructs an elongate cell at an angle with the horizontal of from 30° to 60°. It turns on its back therein (fig. 11) and begins transformation to the true pupa. The process requires several days, the exact time depend-

[2] RILEY, C. V., PACKARD A. S., and THOMAS, CYRUS. OP CIT., p. 299.

ing on the prevailing temperature. Pupæ have been secured beginning May 27 and continuing until August. Five that were handled in confinement between May 27 and July 24 had an average pupal period of 18 days.

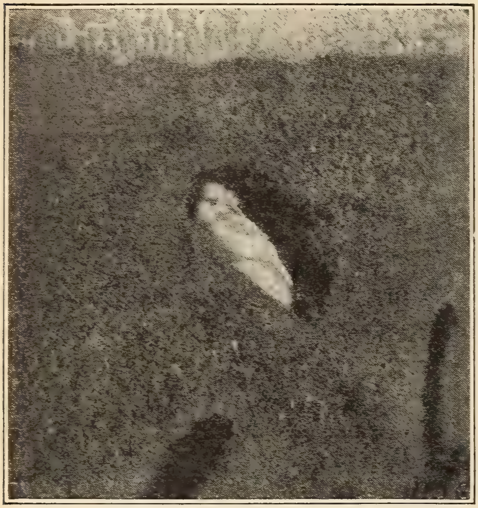

FIG. 11.—Pupa of blister beetle *in situ* in cell.

EMERGENCE OF ADULT.

As the time for emergence approaches, the tips of the appendages begin to darken. The coloration spreads gradually throughout the appendages and into the body. Several days before the emergence of the adults twitching movements begin in the tarsi. These become more vigorous toward the end of the pupal period, finally involving the legs and oral appendages. During its struggles the beetle rights itself and explores the narrow confines of its chamber. A thin, transparent, parchment-like membrane loosens on the surface of its body and is torn beyond recognition by the sharp tarsal claws. Adults from pupæ that have formed against the walls of glass containers have remained in the cells for several days after transformation before digging to the surface. Whether or not such is the case when light is excluded was not determined.

MACROBASIS UNICOLOR KIRBY.

The data secured on *Macrobasis unicolor* add nothing to the general account given for *Macrobasis immaculata*. The third larvæ have been collected by April 15, and eight specimens secured by that time had yielded the adults by May 30. The data on *M. unicolor* indicate that it, also, hibernates as coarctate larva.

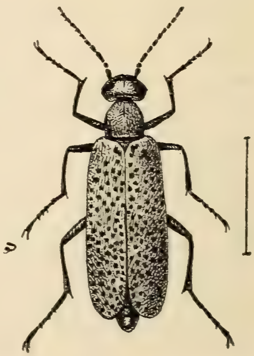

FIG. 12.—The spotted blister beetle (*Epicauta maculata*). Enlarged. (Chittenden.)

RESULTS OF WORK ON EPICAUTA.

DESCRIPTIVE.

EPICAUTA MACULATA SAY.

ADULT.

Adult specimens of *Epicauta maculata* (fig. 12) varied from 10 mm. long by 2.25 mm. wide to 13 mm. long by 3.5 mm. wide, which makes it one of the smallest of our common blister beetles. The color may be either light gray or yellowish, with scattered naked spots of the black background. The black spots vary both in size and location, being barely discernible on some beetles and at least 0.3 mm. in diameter on others.

Egg.

The egg of this species resembles that of *Macrobasis immaculata,* but is smaller.

Larva.

Triungulin (fig. 13).—Length, about 1.25 mm.; width, about 0.4 mm.; widest in front of middle of head just behind eyes, from which point the head tapers posteriorly for the last half or more of its length. In this respect it agrees with triungulins of *Epicauta pennsylvanica* and *E. lemniscata,*[3] but differs from Riley's figure of *E. vittata.*[4] The head of the latter is parallel-sided, resembling *Macrobasis immaculata,* but differing in having a very short posterior portion or neck and in having the eyes located about the middle of the length of the head. In all triungulins examined by the writer the eyes are located much nearer the anterior portion of the head.

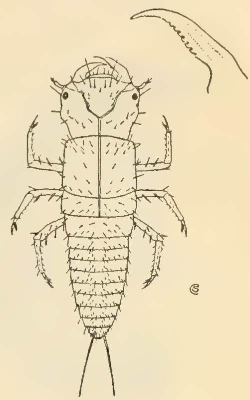

Fig. 13.—*Epicauta maculata:* Triungulin. Enlarged.

In other respects the triungulin of this species resembles that of *Macrobasis immaculata* (p. 8).

Active larvæ.—Neither the growing stages nor the third larva were recognized so they could be described.

Coarctate larva.—The writer's records show one coarctate larva that measured 9 mm. long by 4 mm. wide which yielded an adult of this species.

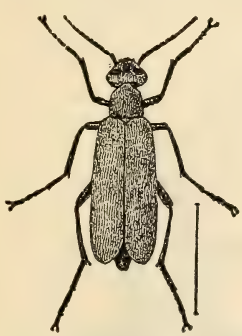

Fig. 14.—*Epicauta cinerea:* Adult. (Chittenden.)

Pupa.

The pupa of this species was not described for lack of authentic material. It is similar in color and appearance to that of *Macrobasis immaculata,* but much smaller.

Epicauta cinerea Forst.

Adult.

Length of adult *Epicauta cinerea* (fig. 14), from 8 to 17 mm.; width, 1.75 to 4 mm.; shape slender, with sides of elytra almost parallel; color, bluish to light or yellowish gray.

Egg and Active Larva.

Neither the egg nor any of the active larval stages of this species were secured for descriptive purposes.

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[3] Triungulins of this species were kindly furnished by Mr. Thos. H. Jones of the Bureau of Entomology.

[4] Riley, C. V., Packard, A. S., and Thomas, Cyrus, op. cit., Pl. IV, fig. 2.

Coarctate Larva.

Length of coarctate larva (fig. 15), 7.45 mm.; width, 4.08 mm.; 28 specimens varied in length from 6.25 to 9 mm. and in width from 3.25 to 5 mm. Shape much more robust than that of the coarctate larva of any other species thus far

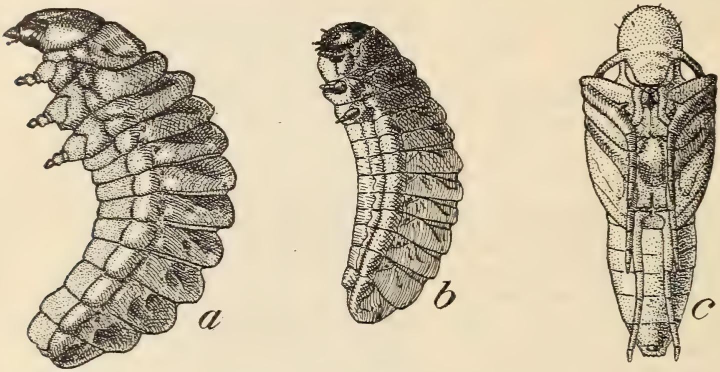

Fig. 15.—The gray blister beetle (*Epicauta cinerea*): *a*, Scarabaeidoid larva; *b*, third larva; *c*, pupa.

secured, being almost straight longitudinally on the venter and without the angular lateral ridges, thus leaving them almost circular in abdominal cross section; color a rich reddish brown, darker than any other species with which the writer has worked.

Pupa.

The single pupa (fig. 16, *c*) of this species which was measured had a length of 12 mm.

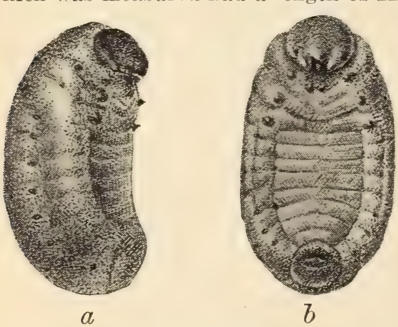

Fig. 16.—*Epicauta cinerea*: *a*, Coarctate larva, lateral view; *b*, coarctate larva, ventral view.

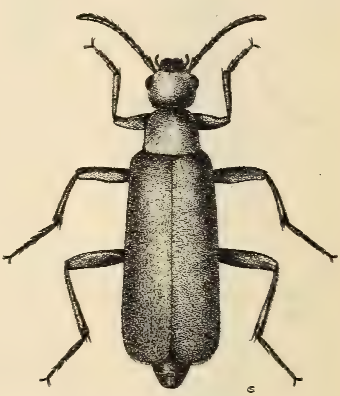

Fig. 17.—*Epicauta sericans*: Adult. Enlarged.

and a width of 4 mm. In shape, color, and general appearance it resembles the pupa of *Macrobasis immaculata*, but is not so large.

Epicauta sericans Lec.

Adult.

Of 29 adult specimens of *Epicauta sericans* (fig. 17) the variation in length was from 9.5 to 13 mm., with an average of 10.8 mm.; color, light reddish brown through yellow and gray to almost silvery; antennæ reaching to the elytra, the segments except the second being nearly as broad as long. The second segment is nearly twice as long as thick; sides of elytra nearly parallel.

Egg and Young Larva.

The egg has not been secured or the growing stages of the larva recognized.

Coarctate Larva.

The average of 10 coarctate larvæ was 6.875 mm. in length by 3.8 mm. in width. They are reddish brown, but not so dark as those of *E. cinerea*, and the lateral ridges are present and distinctly angular.

Third Larva.

The third larvæ are 7 to 8 mm. long by 2.5 to 3.5 mm. wide. In shape, color, and general appearance they resemble those of *Macrobasis immaculata*.

Pupa.

A description of the pupa has never been secured.

Epicauta pennsylvanica De G.

Adult.

Epicauta pennsylvanica (fig. 18) is the smallest of the black blister beetles that occur in Kansas. Of 18 specimens, the length varied from 8.5 to 14 mm., averaging 10.3 mm., and the width from 2 to 4 mm., averaging 2.88 mm.; shape rather slender; color dull black.

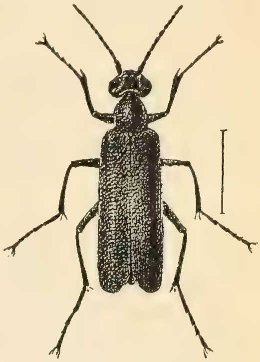

Fig. 18.—The black blister beetle (*Epicauta pennsylvanica*): Adult. Enlarged. (Chittenden.)

Egg.

The egg resembles that of *Macrobasis immaculata*, but is much smaller.

Triungulin Larva.

Length of triungulin larva (fig. 19) about 1.3 mm.; width about 0.3 mm., widest through the head about midway of its length, which is just behind the eyes, and tapering to the prothorax, into which it telescopes slightly; color, brownish yellow, translucent. In shape and general appearance it resembles the triungulin of *Macrobasis immaculata*.

None of the other larval stages have been secured, even the coarctate larva of this species having escaped recognition.

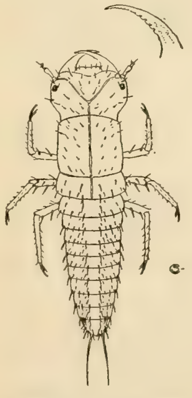

Fig. 19.—*Epicauta pennsylvanica*: Triungulin. Enlarged.

LIFE HISTORY AND HABITS.

Epicauta maculata Say.

Oviposition.

While on the staff of the Kansas Experiment Station the writer observed oviposition by a female of *Epicauta maculata*, as well as by a female of *Macrobasis immaculata*. Both were working at the same time, being discovered only a few yards apart in the edge of a field. The process was identical with both females, lasting from before 3.30 p. m. until after 6 p. m., as described under *M. immaculata*. The cavities to receive the eggs were made exactly alike—bell-shaped, with the flaring end down and the eggs reposing in a further depression at the center of the bottom of the bell; but the cavity made by *E. maculata* was only about 1 inch deep, as compared with 1½ inches for the other. Several hundred eggs were in each nest.

In confinement eggs have been secured from July 27 to September 22. Confined females lose their instinct for careful oviposition, placing their eggs under a clod or leaf, or scattering them about on the surface without covering.

INCUBATION.

Incubation proceeds as described for *Macrobasis immaculata.* Eggs secured July 31 hatched August 18, and others deposited August 1 hatched August 22, giving an incubation period of from 18 to 21 days.

HABITS AND GROWTH OF LARVA.

The newly hatched larvæ soon become active. Their activities parallel those described for the triungulin of *Macrobasis immaculata.*

The coarctate larvæ are found near the surface, being but little deeper than the lower ends of the grasshopper egg capsules. Many are taken directly from the capsules. In confinement one third-stage larva appeared on May 6, the pupa was fully formed on May 12, and the adult came forth on May 25. The adults appear in numbers earlier than those of any other species of Cantharini taken in this region, this fact being corroborated by field observations. Since eggs were secured on September 27 it is evident that the adults occur throughout the summer.

EPICAUTA CINEREA FORST.

Oviposition by *Epicauta cinerea* has never been observed, nor have the habits of the larvæ preceding the coarctate been studied.

The coarctate larvæ have been collected at all seasons of the year and wherever grasshopper eggs are to be found. They occur from 2 to 5 inches below the surface in nearly upright cells, in which the larvæ are disposed as described for *Macrobasis immaculata.* The earliest date at which third larvæ have been collected was between April 12 and April 16. They are frequently found during the last week in May.

According to the writer's records the earliest pupation in confinement occurred May 8; but an adult for which the pupation was not recorded emerged on the same date, thus indicating pupation at least 10 days earlier. Other transformations follow rapidly and continue through the summer. From the dates recorded for the transformation of this species it would seem that its appearance in the field should precede that of *Epicauta maculata*, which, as stated above, is the earliest to appear of the Cantharini of this region. The apparent contradiction is reconciled by the occurrence of most of the coarctate larvæ at greater depths than those of *E. maculata*, which prevents the reception of sufficient heat to start activity early in the season. Only those individuals of *E. cinerea* that are near the surface appear with the main brood of *E. maculata.*

EPICAUTA SERICANS LEC.

Adults of *Epicauta sericans* have been collected from June 6 to September 11. They are commonly found feeding in flowers on many kinds of plants, often being taken on sunflower (*Helianthus* spp.), other Compositæ, the scurvy pea (*Psoralea tenuiflora*), alfalfa, peanuts, and other cultivated legumes.

The eggs have not been secured or the growing stages recognized. The coarctate larvæ have been collected during the fall, winter, and spring, and emergence begins early in June. For these reasons this species is believed to develop normally one generation annually, hibernating as coarctate larva; but instances of retarded development have occurred, and these are considered under the proper heading.

EPICAUTA PENNSYLVANICA DE G.

The adults of the small black blister beetle have been collected at Garden City, Kans., from August 17 to November 11. At the latter date about half the adults had died, and the remainder were so stiff from cold that they could not cling to vegetation. They were first found on blossoms of the goldenrod (*Solidago* spp.), but later fed on the blossoms of the many-flowered aster (*Aster multiflora*), alfalfa, and a few other plants. Eggs were not found in the field, but were secured from adults confined on earth in a battery jar. On October 20 a cluster of 363 was deposited about half an inch below the surface. The eggs hatched on November 15, which was too late for development to proceed. This agrees with Riley's statement [5] that the species evidently hibernates as the triungulin.

IRREGULAR DEVELOPMENT.

During the progress of these investigations some marked variations were observed in the time required for development. Of active, grown larvæ collected at Garden City, Kans., during the period from April 12 to 16, 1916, three transformed to coarctate larvæ of *Epicauta cinerea* by May 7. When examined again on May 29 they were found dead as third larvæ, having perished from lack of moisture. Under the circumstances it is impossible to say whether these specimens were mature scarabaeidoid or the third larvæ when collected. Most specimens of *Epicauta cinerea* that have

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[5] RILEY, C. V., PACKARD A. S., and THOMAS, CYRUS. Op cit., p. 301.

been reared came from coarctate larvæ that were collected during the fall and winter.

Seven mature coarctate larvæ of one type, collected during the winter of 1913–14 were placed on soil in a perforated tin box. During the summer the box was buried in the insectary at a depth of about 2 inches and forgotten. The writer chanced upon it again November 25, 1914, finding in it six coarctate larvæ, one dead third larva, and seven cast coarctate skins. Only one explanation is possible. The coarctate larvæ all transformed to the third larvæ, and six of them reverted to the coarctate condition again. The seventh perished. On May 30, 1915, the six coarctate larvæ were separated into two lots of three each. One lot was placed in dry earth, the other in damp earth. The former showed no signs of activity. Of those in moist earth, one had decayed by July 2, another had transformed to third larva, and the third specimen remained unchanged and apparently healthy. The third larva continued its transformations, and on July 24 yielded an adult of *Epicauta sericans*. The four unchanged coarctate larvæ were stored in dry soil until the spring of 1916. Upon being moistened they decayed at once.

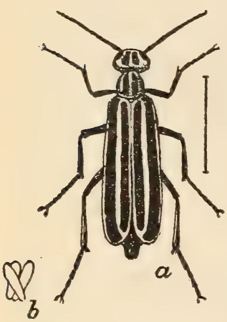

FIG. 20.—Striped blister beetle (*Epicauta vittata*): *a*, Female beetle; *b*, eggs. Enlarged. (Chittenden.)

A coarctate larva obtained during the winter of 1913–14 did not yield the adult until July 7, 1915. This proved to be *Macrobasis immaculata*.

Riley[6] reports cases of retarded development in *Epicauta vittata* (figs. 20, 21). From the same batch of eggs he had beetles mature in one, two, and three years. Regarding one which required three years he wrote as follows:

In this case the individual, though submitted to exactly the same conditions as the other specimens, which had simultaneously hatched with it—but which went through all their transformations within either one or two years—remained dormant for nearly three years, with their repeated changes of season and temperature. With the exception of the first winter, when it was kept indoors without freezing and when development should have been presumably hastened, the specimen was kept in a tin box buried the proper distance beneath the ground out of doors, so as to be as nearly as possible under natural conditions.

Continuing the discussion of retarded development, he says:

In the case of our blister-beetles, depending as they do on locust eggs, and especially in the case of those which feed particularly on the eggs of migratory species, it is not difficult to perceive how this trait may prove serviceable to the species possessing it. Migratory locusts occur in immense numbers in some

[6] RILEY, C. V., PACKARD, A. S., and THOMAS, CYRUS. SECOND REPORT, U. S. Ent. Comm. Dept. Interior, 1878 and 1879, pp. 260–261. 1880.

particular part of the country at irregular intervals, and there are periods of years of absolute immunity from their presence in the same regions. The young blister-beetles that hatch the year following the advent of the locusts in immense numbers may frequently find few or no locust eggs upon which to prey, and the great bulk of them would, as a consequence, perish; while the young from such exceptional individuals as should not develop till two, three, or more years after a locust invasion might stand a much better chance of finding appropriate food and of thus perpetuating the species. In this case and in most other cases of retarded development with which we are familiar, the exceptional retardation may and does become a benefit to the species, enabling it to bridge over periods of adversity. And we can see how, by the preservation of such favored individuals, the habit of irregular development may have become fixed in the species as a consequence of surrounding conditions and circumstances which render it advantageous.

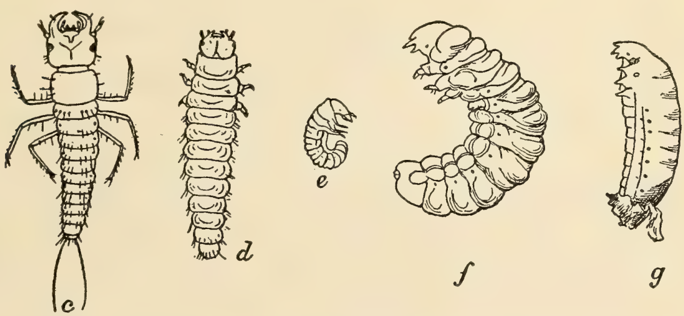

FIG. 21.—Striped blister beetle (*Epicauta vittata*): *c*, Triungulin larva; *d*, second or caraboid stage; *e*, same as *d*, doubled up as in pod; *f*, scarabacoid stage; *g*, coarctate larva. All except *e* enlarged. (After Riley.)

In these two paragraphs Riley points out the tendency to irregular development which is exhibited in blister beetles, and the benefit which it undoubtedly is to the species. He discusses the irregularity as a tendency which is already acquired, though indicating its origin "as a consequence of surrounding conditions and circumstances." Whether he believed that irregular development could be induced in individuals by subjecting them to certain conditions he does not state.

During retarded development the additional time involved is spent in the coarctate larva stage. Low temperature inhibits development in any stage, but in the other stages activity is resumed with increased temperature. The hardy triungulin can survive for two or three weeks without food, but Riley reports[7] that the first molt is usually experienced about the eighth day after the first taking of food, indicating that normal development begins with reception of nourishment. Entering an egg-capsule automatically limits the food a

[7] RILEY, C. V., PACKARD, A. S., and THOMAS, CYRUS. FIRST ANNUAL REPORT U. S. Ent. Comm. Dept. Interior, U. S. Geol. Survey, 1877, p. 299. 1878.

triungulin can secure. If the eggs in a capsule fall short of the minimum requirement to carry the larva to maturity it perishes; if they exceed this minimum the difference is registered by the size of the beetle which develops. Consequently, in a given species there is great variation in size of the adults. The third larva is injuriously affected by insufficient or excessive soil moisture; however, the variation or limits in which it is safe are commonly prevalent in semiarid regions during spring and early summer. The pupæ are exceedingly sensitive, being injuriously affected by excessive soil moisture, handling, high temperature, or a soil rich in humus. Even prolonged high humidity injures them. Many on which a little earth dropped or that are exposed during an examination gradually turn dark and decay.

The coarctate larvæ, on the other hand, are resistant to handling, to exposure, to drying, or to any soil disturbance that does not crush them. They have even become overgrown by saprophytic soil fungus while in storage without loss of vitality. Excessive soil moisture, however, or continued high humidity, such as is necessary to produce conditions that favor the development of fungus, is usually detrimental. The position of the coarctate larvæ in the soil facilitates drainage, standing, as they do, on end in the old exuvium and touching the soil only in the dorsal region of the prothorax. Treatment to which they were submitted by the writer also demonstrated their ability to withstand extreme exposure and drying. Coarctate larvæ that remained for months in open containers without soil, in open containers on dry soil, and buried in pulverized dry soil have transformed shortly after being placed in moist soil.

When coarctate larvæ are very dry during the spring and early summer the rigid skin often splits immediately if water is thrown directly upon it, the larvæ emerging within a few minutes. Such dry coarctate larvæ also soon transform when placed on moist earth.

Coarctate larvæ that are kept dry during the spring and summer may or may not give forth the third larvæ when moistened in the fall. The instance cited of seven that were buried and forgotten and later found to have become third larvæ, six of which reverted to the coarctate stage, illustrates another mode of behavior of such specimens. During the time they were buried the insectary was flooded by run-off irrigation water from an adjacent field. The floor was barely covered by water and dried quickly, especially in the end where the box was buried. It is possible that enough water penetrated the box to initiate development, but not to complete it. The six larvæ that resumed the coarctate stage did so as a protective measure, or else the coming of cold weather caused this resumption. The writer attributes their reversion to one of these alternatives. Granting the correctness of these deductions, it indicates a more complete adjustment to the semiarid conditions under which they thrive best than anything in Riley's writings that have come before the writer.[8]

An attempt will be made to apply these conclusions to field conditions as found in western Kansas: The rainfall is most abundant in spring; it gradually decreases through the summer, but increases again toward fall. The coarctate larvæ that receive sufficient moisture transform as soon as the temperature becomes favorable, and usually are able to complete their life history before the moisture becomes deficient. If for any reason—lack of rainfall, impervious soil, or deflection of rainfall by sheltering vegetation—the soil moisture is deficient, the coarctate larvæ remain dormant. If, after their appearance, the third larvæ find insufficient moisture they revert to the coarctate stage, and they may behave similarly if low temperature occurs. It is not known how long coarctate larvæ can remain dry in undisturbed cells without impairment of their vitality.

The preceding discussion of the environmental factors responsible for the phenomenon of irregular development in blister beetles is intended not only to present the author's interpretation of his data, but to direct attention to what he believes is a fertile field for research on the factors influencing insect development. The incompleteness of the data will insure the reception of this paper as a report of progress of work done during this period with the available time and material, instead of as a definite statement of results and conclusions.

CONTROL MEASURES.

While the writer was engaged in the work on life history and habits of blister beetles, tests were made of remedies whenever an opportunity occurred. The work on remedies may be considered under two heads: (1) Effect of arsenicals, contact insecticides, and repellents; and (2) control measures in infested fields.

EFFECT OF ARSENICALS, CONTACT INSECTICIDES, AND REPELLENTS.

Arsenicals.

The widely prevalent idea that arsenicals are ineffective against blister beetles was left in doubt in the earlier tests of the poisons by the writer; the beetles would disappear, leaving but few dead ones visible. In order to learn definitely whether the beetles were killed by the poisons single beet plants were sprayed with each kind and beetles confined thereon in cages, 10 beetles being placed in each cage. The experiment was conducted three times during July, 1913, and the data are given in Tables 1, 2, and 3. The kind of poison

[8] The writer has read only the reports of the U. S Entomological Commission.

used is indicated at the heads of the columns, with its strength in pounds to so many gallons of water. With Paris green an equal quantity of quicklime was used.

TABLE 1.—*First experiment in the use of arsenicals, contact insecticides, and repellents against blister beetles; begun June 30, 1913.*

Date.	Number of beetles dead after spraying with—			
	Paris green, 1-1-25.	Zinc arsenite, 1-20.	Lead arsenate, 1-12½.	Bordeaux mixture, 4-4-50.
July 1..	0	0	0	0
2..	6	3	0	0
3..	10	8	0	0
4..	....	10	0	0
5..	....	....	0	0
7..	....	....	5	1

When the experiment was discontinued the beet sprayed with Bordeaux mixture was defoliated with only one beetle dead, and the one sprayed with lead arsenate was badly damaged with only five of the beetles dead. Lead arsenate made such a poor showing that its strength was doubled in the second experiment.

TABLE 2.—*Second experiment in the use of arsenicals, contact insecticides, and repellents against blister beetles; begun July 7, 1913.*

Date.	Number of beetles dead after spraying with—			
	Paris green, 1-1-25.	Zinc arsenite, 1-20.	Lead arsenate, 1-6¼.	Bordeaux mixture, 4-4-50.
July 8.	0	0	0	0
9.	3	10	2	0
10.	10	....	8	0
11.	....	....	10	3
12.	....	....	....	5

The beets sprayed with Bordeaux were again badly defoliated, but the increased strength of lead arsenate prevented much damage.

TABLE 3.—*Third experiment in the use of arsenicals, contact insecticides, and repellents against blister beetles; begun July 22, 1913.*

Date.	Number of beetles dead after spraying with—			
	Paris green, 1-1-25.	Zinc arsenite, 1-20.	Lead arsenate, 1-10.	Bordeaux mixture, 4-4-50.
July 24.	1	0	1	0
25.	3	2	1	2
26.	7	5	2	2
28.	10	7	4	7
29.	....	10	6	8
30.	....	....	7	8

During these experiments Paris green has, except in one instance, killed the beetles in less time than zinc arsenite. Its killing time has been consistently shorter throughout than lead arsenate in quantities that it is practicable to apply. The results from Bordeaux mixture do not justify its use in this connection. Of the beetles poisoned during these experiments very few remained in sight. Most of them were to be found among the bases of the stems or under clods about the base of the plant.

Repellents.

To determine what substances possess the greatest repellent properties, part of a cluster of beet plants was sprayed with Paris green, part with Bordeaux mixture, part with fish-oil soap, part with nicotine sulphate, and the remainder with water. A large screen cage was then set over the beets and about 70 beetles introduced. They scattered over the plants indiscriminately, but none fed on the ones treated with Paris green and Bordeaux. A little foliage was eaten from the plants treated with nicotine sulphate and soap. The beets sprayed with water were defoliated.

Contact Insecticides.

Lime-sulphur in strengths up to 30 per cent did not produce satisfactory results. The weaker solutions had no effect on the beetles and the stronger ones stunted the beets.

Whale-oil soap, 1 pound to 2 gallons of water, killed beetles that could be thoroughly wet, but injured both sugar beets and potatoes on which the applications were made. No other contact insecticides were tested.

CONTROL MEASURES IN INFESTED FIELDS.

On June 23, 1913, blister beetles attacked a half-acre field of sugar beets at the Garden City branch of the Kansas Experiment Station. Most of them were the small-spotted blister beetle (*Epicauta maculata*), but the outbreak included a few of a large gray blister beetle or spotless blister beetle (*Macrobasis immaculata*). The little four-leaved plants had been stripped to the midribs over most of the field, and on the remainder the beetles were feeding. They were also crossing the road into a patch of Irish potatoes.

The beets where the beetles were feeding were sprayed with 1 pound of lead arsenate in 9 gallons of water. Part of the potatoes were sprayed with 1 pound of zinc arsenite in 32 gallons of water, part with 1 pound of Paris green and some lime in 40 gallons of water, and the remainder left as a check. The beets were so small and so badly eaten before being sprayed that they never recovered.

The sprayed potatoes were only slightly injured by the beetles, but the unsprayed ones were defoliated (fig. 22).

On July 5 a small patch of potatoes, grown by Dr. C. O. Townsend of the Bureau of Plant Industry for experimental purposes, was attacked by blister beetles of several species. The potatoes were being sprayed with Bordeaux mixture, so Paris green was added thereto for part of the patch and zinc arsenite for another portion. The potatoes designed to be left as a check on the Bordeaux treatment were sprayed with Paris green alone. These potatoes suffered

FIG. 22.—Field of potatoes attacked by blister beetles; strip through middle left unsprayed. Sprayed on left and on extreme right. (Photo by Lill, Bureau of Plant Industry.)

very little during the attack. Another invasion occurred three weeks later, at which time the potatoes were all sprayed with Paris green, 1 pound to 25 gallons of Bordeaux where the latter was used, and the same strength alone on the remainder. No damage resulted from the second attack.

Three acres of sugar beets belonging to Mr. D. A. Sheaks, of Garden City, Kans., were attacked by blister beetles that gathered in one edge of the field, most of them being large beetles (*Macrobasis immaculata*). On July 26 about half of the field, including the infested portion, was sprayed with 1½ pounds of Paris green and some stone lime in 50 gallons of water. The beetles ceased their injury on the sprayed portion of the field, those that escaped collecting on beets on the unsprayed area. Not more than 25 per cent of them were killed.

On July 28 blister beetles from a freshly cut field of alfalfa gathered in a one-acre field of beets. About one-third of the patch was sprayed, 1 pound of Paris green and some lime in 25 gallons of water being used. Another half-barrel of the solution was then prepared, the nozzles were changed for others having smaller openings, and the spraying was completed, only about a third of the second half-barrel of solution being used. The next morning dead beetles were numerous among the bases of the leaves and under clods. Those that remained alive were mostly stupid and helpless. The beetles were *Epicauta cinerea* and *Macrobasis unicolor*, which are of only medium size.

On July 25, 1914, a test was started at the Garden City branch of the Kansas Experiment Station on two tenth-acre plats that had been attacked by blister beetles to determine the comparative value of spraying and dusting. Paris green was used as a spray, 1 pound to 25 gallons of water; as a dust, 1 pound to 5 pounds of powdered lime; and lead arsenate was used as a dust without dilution. Part of each plat was treated with each formula. There was no perceptible difference in results. Of the small beetles (*Epicauta maculata*) a large percentage were killed, but of the large ones (*Macrobasis segmentata* Say, and *Macrobasis immaculata*) more escaped than were killed.

DRIVING.

When disturbed while feeding blister beetles drop or climb down rapidly to the ground and run away, sometimes traveling several yards before stopping to feed. Fields that are attacked by them may often be saved by taking advantage of this habit and driving them off. Several persons form a line and advance through the field, knocking the beetles from the plants with brooms, sticks, or pieces of brush. The advance should be slow, allowing time for killing any beetles that fall behind. At Garden City five persons in half a day drove the beetles out of 25 acres of beets. The method is to be recommended where most of the beetles are of the large varieties, where the plants are small and unable to survive defoliation if it occurs, or where for any reason immediate results must be secured. It is not practicable where abundant foliage affords concealment for the beetles.

SUMMARY OF CONTROL MEASURES.

Attacks by the smaller beetles are easily controlled by spraying with 1 pound of Paris green with lime in from 25 to 40 gallons of water. Many of the larger species are killed by the stronger solution. Dusting with 1 pound of Paris green to 5 pounds of powdered lime or with pure lead arsenate is effective against the small beetles, but can not be recommended against the larger ones. Driving the beetles out of the field is recommended wherever the work of the beetles must be checked at once.

The application of control measures for blister beetles must take into account the relation of these insects to grasshoppers. As long as the latter are present their eggs provide food for the young of the beetles. The destruction of the grasshopper eggs leaves the blister-beetle larvæ without food, thus being doubly beneficial. Incorporating into the farm practice of a community the simple measures that are known to hold grasshoppers in check will eliminate the danger from blister beetles.

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